

What is claimed is:

1. A group III-nitride semiconductor substrate comprising:

a  $\text{ZrB}_2$  single crystal base having a defect density of  $10^7 \text{ cm}^{-2}$  or less;

a low-temperature buffer layer consisting of a  $\text{B}_x\text{Al}_y\text{Ga}_z\text{In}_{1-x-y-z}\text{N}$  ( $0 \leq x \leq 1, 0 \leq y \leq 1, 0 \leq z \leq 1, 0 \leq 1-x-y-z \leq 1$ ) single crystal which is grown or deposited on said  $\text{ZrB}_2$  single crystal base substantially without creation of any Zr – B – N amorphous nitrated layer caused by the reaction between a nitrogen atom and said  $\text{ZrB}_2$  single crystal base; and

a semiconductor layer consisting of a  $\text{B}_a\text{Al}_b\text{Ga}_c\text{In}_{1-a-b-c}\text{N}$  ( $0 \leq a \leq 1, 0 \leq b \leq 1, 0 \leq c \leq 1, 0 \leq 1-a-b-c \leq 1$ ) single crystal grown on said low-temperature buffer layer, said semiconductor layer having an element-forming surface with a dislocation density of  $10^7 \text{ cm}^{-2}$  or less in its entirety.

2. A semiconductor optical element formed on the semiconductor substrate as defined in claim 1.

3. The semiconductor optical element as defined in claim 2, which includes an electrode formed on the side of said base.

4. A method of producing a group III-nitride semiconductor substrate, essentially consisting of:

a first step of forming a low-temperature buffer layer consisting of  $\text{B}_x\text{Al}_y\text{Ga}_z\text{In}_{1-x-y-z}\text{N}$  ( $0 \leq x \leq 1, 0 \leq y \leq 1, 0 \leq z \leq 1, 0 \leq 1-x-y-z \leq 1$ ), on a  $\text{ZrB}_2$  single crystal base having a defect density of  $10^7 \text{ cm}^{-2}$  or less, at a base temperature allowing said

low-temperature buffer layer to be grown or deposited on said  $\text{ZrB}_2$  single crystal base substantially without creation of any  $\text{Zr} - \text{B} - \text{N}$  amorphous nitrided layer; and

a second step of successively to said first step, growing a single crystal film consisting of  $\text{B}_a\text{Al}_b\text{Ga}_c\text{In}_{1-a-b-c}\text{N}$  ( $0 \leq a \leq 1$ ,  $0 \leq b \leq 1$ ,  $0 \leq c \leq 1$ ,  $0 \leq 1-a-b-c \leq 1$ ), directly on said low-temperature buffer layer, to form a semiconductor layer consisting of  $\text{Al}_a\text{Ga}_{1-a-b}\text{In}_b\text{N}$  ( $0 \leq a \leq 1$ ,  $0 \leq b \leq 1$ ,  $0 \leq 1-a-b \leq 1$ ) which has an element-forming surface with a dislocation density of  $10^7 \text{ cm}^{-2}$  or less in its entirety.

5. The method as defined in claim 4, wherein said low-temperature buffer layer is formed as a single crystal at the time said first step is completed.

6. The method as defined in claim 4, wherein said low-temperature buffer layer is polycrystalline or amorphous at the time said first step is completed, and formed as a single-crystal at the time said second step is completed.

7. The method as defined in either one of claims 4 to 6, wherein said low-temperature buffer layer has a thickness in the range of 10 nm to 1  $\mu\text{m}$ .